REMARKS

Examiner S. Ahmed is thanked for his thorough examination of the Prior Art.

Favorable reconsideration of this application in light of the above amendments and the following remarks is respectfully requested.

The invention teaches a multi-step method for shutting down the dry-etch process. The ICP rf power is reduced between each of these consecutive power-down steps of the dry-etch process, the complete power-down sequence consists of six steps. These six steps are executed in sequence and without interruption and form the totality of the dry-etch chamber power-down procedure.

Specification

The specification has been amended by providing separate descriptions for each of the drawings that are part of the application.

Drawings

The drawings have been amended as kindly suggested by Examiner, a copy of the updated drawings is attached.

Claim rejections - 35 U.S.C. § 112

Reconsideration of the rejection of claim 2 under 35 U.S.C 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention is respectfully requested based on the following.

The Examiner is thanked for pointing out the various antecedent basis problems in the claims. The claims have been carefully reviewed and amended to correct those problems the Examiner pointed out, in addition to others. In addition, punctuation marks have been added to the claims where appropriate in order to improve legibility of the claims. All claims are now believed to be in allowable condition.

In light of the foregoing response, applicant respectfully requests that the Examiner's rejection of claim 2 under 35 U.S.C 112, second paragraph, be withdrawn.

Claim rejections - 35 U.S.C. § 102

Reconsideration of the rejection of claims 1-3 and 5-6 under 35 U.S.C 102(b) as being anticipated by Blanchard et al. (US Patent 5,221,425) is respectfully requested based on the following.

Blanchard et al. provide for:

- (col. 1, line 8 e.a.): "a method for reducing foreign matter deposited on a wafer during reactive ion etching"; the instant inventions provides for, claim 1, "a method of reducing dry-etch cleaning chamber particle count at the end of power-down for a dry-etch chamber"; this is further confirmed by the instant invention by "following a dry-etch chamber power-down procedure" as specified in claims 7, 8-13, 14 and 15, independent claim 16 and the dependent claims (17, 18) to claim 16
- the difference between Blanchard et al. and the instant invention is essentially clear from the above mentioned item, that is Blanchard et al. provides the deposition of foreign matter which is deposited on a wafer during RIE, the instant invention reduces particle count, not during or as part of RIE processing, but after the reactive chamber has been used for RIE processing and the reactive chamber is, as part of

the invention, powered-down in such a manner that foreign particle count inside the chamber is reduced at the end of the power-down cycle. This is confirmed by the claims of the invention, claim 1 identifies the "following a dry-etch chamber power-down procedure" which is further specified in claims 7, 8-13, 14, 14, independent claim 16 and the dependent claims 17 and 18 to claim 16

- as a further difference between Blanchard et al. and the instant invention, a quote is extracted from the introductory statement of the specification, page 1, as follows: "and more specifically to a method to reduce the dry-etch chamber particle level during the power-down procedure of the dry-etch cleaning process for lithography masks"; from this follows that Blanchard et al. are concerned with reducing particle count on the surface of a wafer during RIE processing, the instant invention is concerned with and applies to reducing creative chamber particle content and by thereby reducing particle concentrations on the surface of lithographic masks that are used in the reactive chamber
- to further quote from the specification, page 4: "Using current one-step cleaning procedures results in a violent transition of the plasma in going from the operating condition of rf-on to rf-off. This results in uncontrolled particle levels within the dry-etch chamber, a condition that

is very detrimental to the proper operation and control of the dry-etch process. The present invention addresses this operational aspect of the dry-etch process and teaches a method of significantly reducing the particle count of residues or deposits of residual reaction products in the dry-etch chamber at the end of the dry-etch process."

- the instant invention changes the conventional one-step cleaning process (page 5 of the specification and Figs. 1a through 1e of the specification), to a six step sequence of steps, the "power-down procedure" that is claimed in claims 1, 7, 8-13, 14,14 and 16 with the dependent claims thereto, also described using Figs. 2a through 2e of the specification
- in order to avoid becoming repetitive, Applicant will respectfully conclude with the stated main objective of the invention, page 9 of the specification: "It is the primary objective of the invention to provide a method of reducing particle count within the dry-etch chamber at the end of the dry-etch chamber cleaning process."
- finally, Figs. 3a and 3b of the instant invention show a graphic depiction of the particle count for both the original Prior Art one step rf power-down mode and the multi-step rf power-down mode of the invention and

- Figs. 4a and 4b of the instant invention show a graph further illustrating the results obtained using the power-down procedure of the invention.

In light of the foregoing response, applicant respectfully requests that the Examiner's rejection of claims 1-3 and 5-6 under 35 U.S.C 102(b) as being anticipated by Blanchard et al. (US Patent 5,221,425), be withdrawn.

Claim rejections - 35 U.S.C. § 103

Reconsideration of the rejection of claim 1-22 under 35 U.S.C 103(a) as being unpatentable over Blanchard et al. (US Patent 5,221,425) is respectfully requested based on the following.

The difference between Blanchard et al. and the instant invention has been argued supra and will therefore not be repeated at this time.

To address Examiner's cited use of ICP dry-etchers as being implied by or readily derived from Blanchard et al., Applicant respectfully refers to the reference work "ULSI Technology" by

C. Y. Chang and S./ M. Sze, page 349. e. a. and extracts a number of quotes from this reference:

- "as feature sizes for ULSI continue to decrease, the limits of the conventional rf capacitive-coupled parallel system are being approached."
- "Other types of high-density plasma sources, such as inductive-coupled plasma (ICP) sources or helicon plasma sources, may become the main plasma sources for future ULSI processing."

From these two quotes it is clear that the invention provides a method of cleaning dry-etch processing chambers that is suited for and aimed at ULSI technology, that is a technology that is considerably advanced from the technology that is addressed by Blanchard et al. This can be summarized as follows:

- Blanchard et al. do not address a power-down procedure but merely use power manipulation in the processing chamber to achieve reducing foreign matter on a wafer that is etched in a reactive ion etching process
- Blanchard et al. do not provide for reducing particle level during the power-down procedure of the dry-etch cleaning process for lithography masks

- Blanchard et al. do not provide methods and procedures for particle reduction that can be applied in an era of sub-micron. ULSI device features; for these latter technologies, ICP dry-etch chambers are one of the preferred dry-etch tools
- Blanchard et al. do not provide multiple processing parameters for a method for reducing foreign matter on a wafer but rely exclusively on control and adjustment of the rf voltage in the etch chamber; this differs from the instant invention where conditions for a power-down procedure include operating conditions of pressure, conditions of rf power supplied to the ICP coil of the dry-etch chamber, conditions of rf power supplied for the RIE etch, a particular gas (O_2) entered into the dry-etch chamber and a time during which each of the six steps of the power-down procedure of the invention is to remain in force; this is specified in claims 8-13, claims 16, 17 of the instant invention; of further interest is that, for the processing conditions of the invention, the time of the steps is also varied with the first step of the power-down procedure requiring 2.5 minutes (claims 8, 16) while the remaining steps require 30 seconds (claims 9-13, 16, 17); this is therefore not a case of finding an optimum operating parameter, as provided by Blanchard et al., but of using a number of control parameters (not cited by Blanchard et al.) which collectively are aimed

at and achieve reducing particle count at the end of the power-down cycle.

In light of the foregoing response, applicant respectfully requests that the Examiner's rejection of claims 1-22 under 35 U.S.C 103, as being unpatentable over Blanchard et al. (US Patent 5,221,425), be withdrawn.

We have reviewed the related art references made of record and agree with the Examiner that none of these suggest the present claimed invention. {this paragraph can take the place of the following paragraph "The prior art made of record ...."]

The prior art made of record and not relied upon that is considered pertinent to Applicant's disclosure, that is Gupta et al. (US Patent 5,622,595), Gupta (US Patent 6,139,923) and Ye (US Patent 5,756,400) have been examined and have been found to be of general interest to the invention. These prior art records however do not teach the extent and the detail combined with the flexibility of the present patent application.

Other Considerations

No new independent or dependent claims have been written as a result of this office action, no new charges are therefore incurred due to this office action.

SUMMARY

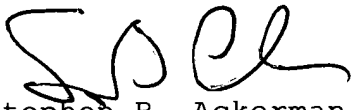
The invention teaches a multi-step method for shutting down the dry-etch process. The ICP rf power is reduced between each of these consecutive power-down steps of the dry-etch process, the complete power-down sequence consists of six steps. These six steps are executed in sequence and without interruption and form the totality of the dry-etch chamber power-down procedure.

It is requested that should Examiner not find the claims to be allowable that he call the undersigned Attorney at his convenience at 845-452-5863 to overcome any problems preventing allowance.

Attached hereto is a marked-up version of the changes made to the specification and claims by the current amendment. The attached page is captioned:

"Version with markings to show changes made."

Respectfully submitted,



Stephen B. Ackerman (Reg. No 37,761)

Version with markings to show changes made.

IN THE SPECIFICATION

1) page 4, lines 19 and 20, replace this paragraph with:

[Fig. 1 shows] Figs. 1a through 1e show the current Prior Art one-step cleaning process as applied to a (photolithography) mask.

2) page 8, line 23, please remove " \"

3) page 10, lines 3 and 4, replace the paragraph:

Fig. 1 shows the sequence of events during the original, Prior Art one-step rf power-down mode.

with the following:

[Fig. 1 shows] Figs. 1a through 1e show the sequence of events during the original, Prior Art one-step rf power-down mode[.], as follows:

Figs. 1a and 1b show conventional conditions referring to a first (Fig. 1a) and a second (Fig. 1b) execution of the same process of cleaning the dry-etch chamber under identical operating conditions of the cleaning operation.

Fig. 1c shows the condition within the dry-etch chamber between the Fig. 1a and Fig. 1b cycle of the dry-etch process.

Fig. 1d shows the repeat of the conventional dry-etch cleaning process.

Fig. 1e shows the distribution of the wall polymer or other residual reaction product molecules after Fig. 1b of the dry-etch cleaning process has been completed and after the internal conditions of the chamber have stabilized.

4) page 10, line 6 and 7, replace the paragraph:

Fig. 2 shows the sequence of events during the multi-step rf power-down mode of the invention.

with the following:

[Fig. 2 shows] Figs. 2a through 2e show the sequence of events during the multi-step rf power-down mode of the invention[.], as follows:

Fig. 2a shows the dry-clean chamber with elements that are contained within and used by the dry-clean chamber. Polymer depositions are also highlighted in Fig. 2a.

Fig. 2b shows the wall polymer or other residual reaction product molecules being distributed throughout the chamber after the rf coil has been activated and the RIE etch has been started. Fig. 2b represents the first step of the power-down sequence of the dry-etch process.

Fig. 2c shows the condition within the dry-etch chamber during execution of dry-etch power-down step 2 within the sequence of six steps of the present invention.

Fig. 2d shows the subsequent steps 4, 5 and 6 of the dry-etch power-down sequence of the present invention.

Fig. 2e shows the final condition within the dry-etch chamber after applying the six step power-down sequence of the present invention.

5) page 10, lines 9, 10 and 11, replace the paragraph:

Fig. 3 shows a graphic depiction of the particle count for both the original Prior Art one step rf power-down mode and the multi-step rf power-down mode of the invention.

with the following:

[Fig. 3 shows] Figs. 3a and 3b show a graphic depiction of the particle count for both the original Prior Art one step rf power-down mode and the multi-step rf power-down mode of the invention[.], as follows:

Fig. 3a shows the Prior Art particle count as a function of time with varying levels of applied rf power.

Fig. 3b shows the particle count obtained under the present invention.

6) page 10, lines 13 and 14, replace the paragraph:

Fig. 4 shows a graph further illustrating the results obtained using the power-down procedure of the invention.
with the following:

[Fig. 4 shows] Figs. 4a and 4b show a graph further illustrating the results obtained using the power-down procedure of the invention[.], as follows:

Fig. 4a represents particle measurements taken with a series of measurements performed over a period of several months. These measurements represent the Prior Art method of power-down for the dry-etch process.

Fig. 4b represents particle count measured also over a period of several months, in this case using the power-down procedure of the invention.

IN THE CLAIMS

Please amend the claims as follows.

2. (Amended) The method of claim 1 wherein said dry-etch chamber is of [the] an Inductive Coupled Plasma (ICP) variety, said dry-etch chamber having a holding member with a surface which holds wafers or masks to be etched and an enclosing member which encloses the holding member to form a chamber for [the] plasma, whereby plasma agitation occurs by an rf coil arrangement surrounding said enclosing member, whereby said rf coil

arrangement produces a large voltage change near the enclosing member thereby enabling [the] cleaning of the enclosing member by the plasma [itself], whereby furthermore plasma gasses can continuously be removed from said enclosing member by means of a suction pump arrangement attached to said enclosing member.

7. (Amended) The method of claim 1 wherein said following a dry etch chamber power-down procedure is a power-down procedure whereby [the] rf power supplied to [the ICP] an Inductive Coupled Plasma (ICP) coil is gradually reduced in a sequence of six steps, each of said six steps to be executed as part of a [particular] sequence and without time interruption, each step immediately following [the] a preceding step in numerical sequence, whereby [the] a time during which [said RIE] Reactive Ion Etching (RIE) is applied varies and is adjusted in accordance with [the] a step within the sequence, wherein said steps are identified as step 1 through step 6.

8. (Amended) The method of claim 7 wherein [the] processing conditions for said step 1 are specified as 30 mt/600 w ICP/15 w RIE/30 sccm O_2/2.5 min.

15. (Amended) The method of claim 7 wherein [the] processing

conditions for said step 2 are specified as 30 mt/560 w ICP/15 w RIE/30 sccm O_2/30 sec.

16. (Amended) The method of claim 7 wherein [the] processing conditions for said step 3 are specified as 30 mt/520 w ICP/15 w RIE/30 sccm O_2/30 sec.

17. (Amended) The method of claim 7 wherein [the] processing conditions for said step 4 are specified as 30 mt/480 w ICP/15 w RIE/30 sccm O_2/30 sec.

18. (Amended) The method of claim 7 wherein [the] processing conditions for said step 5 are specified as 30 mt/440 w ICP/15 w RIE/30 sccm O_2/30 sec.

19. (Amended) The method of claim 7 wherein [the] processing conditions for said step 6 are specified as 30 mt/400 w ICP/15 w RIE/30 sccm O_2/30 sec.

20. (Amended) The method of claim 7 wherein said six step power down procedure is modified to a sequence of N steps, wherein N is a whole integer number other than zero, [and where the] processing conditions for each [of the] consecutive [steps] step are specified as 30 mt/AA w ICP/15 w RIE/30 sccm O_2/30 sec.,

wherein said AA w ICP represents a value of applied power for [the] consecutive steps within said sequence, said applied power to decrease concurrent with increases in [the] a value of N and whereby said applied power varies from an initial high value to a final low value [in incremental numbers], whereby said incremental numbers may or may not be multiples of AA/N and whereby furthermore said initial high and final low values are experimentally determined and optimized for each dry-etch chamber power down procedure.

→ 15. (Amended) The method of claim 1 wherein said following a dry-etch chamber power-down procedure is a power-down procedure whereby [the] rf power supplied to [the ICP] an Inductive Coupled Plasma (ICP) coil is reduced in a sequential and controlled manner during [the] an [elapsed] time of [the] a cleaning process of said dry-etch chamber, whereby at all times during said [elapsed] time there is a one-to-one relationship between [the] rf power supplied to [the ICP] an Inductive Coupled Plasma (ICP) coil and [the elapsed] time of [the] a cleaning cycle, said relationship being defined by a specific mathematical equation [where said equation may be different for different dry-cleaning cycles].

16. (Amended) Providing a method of reducing particle count at the end of Power-down for [a] an Inductive Coupled Plasma (ICP) dry-etch cleaning chamber, comprising the steps of:

providing a ICP dry-etch cleaning chamber;

positioning a workpiece within said cleaning chamber; and

following a dry-etch chamber power-down procedure, whereby said power-down is a six step power-down procedure, whereby said six steps of said power-down procedure follow in a given [numerical and fixed] sequence and without interruption or time-lag in between any of said six steps, and whereby step 1 is specified as 30 mt/600 w ICP/15 w RIE/30 sccm O_2/2.5 min., whereby further step 2 is specified as 30 mt/560 w ICP/15 w RIE/30 sccm O_2/30 sec., whereby further step 3 is specified as 30 mt/520 w ICP/15 w RIE/30 sccm O_2/30 sec., whereby further step 4 is specified as 30 mt/480 w ICP/15 w RIE/30 sccm O_2/30 sec., whereby further step 5 is specified as 30 mt/440 w ICP/15 w RIE/30 sccm O_2/30, whereby further step 6 is specified as 30 mt/400 w ICP/15 w RIE/30 sccm O_2/30 sec.

18. (Amended) The method of claim 16 wherein said six step power down procedure is modified to a sequence of N steps, wherein N is a whole integer number other than zero, [and] where [the] processing conditions for each [of the] consecutive [steps] step are specified as 30 mt/AA w ICP/15 w RIE/30 sccm

O_2/30 sec, wherein said AA w ICP represents a value of applied power for the consecutive steps within said sequence, said applied power to decrease concurrent with increases in [the] a value of N, [and] whereby said applied power varies from an initial high value to a final low value [in incremental numbers whereby said incremental numbers may or may not be multiples of AA/N and whereby furthermore said initial high and final low values are experimentally determined and optimized for each dry-etch chamber power down procedure].

18. (Amended) The method of claim 16 wherein said following a dry-etch chamber power-down procedure is a power-down procedure whereby [the] rf power supplied to [the ICP] an Inductive Coupled Plasma (ICP) coil is reduced in a sequential and controlled manner during [the elapsed] time of [the] a cleaning process of said dry-etch chamber, whereby at all times during said [elapsed] time there is a one-to-one relationship between [the] rf power supplied to the ICP coil and [the elapsed] time of [the] a cleaning cycle [said relationship being defined by a specific mathematical equation where said equation may be different for different dry-cleaning cycles].

19. (Amended) The method of claim 16, [wherein] said dry-etch chamber having a holding member with a surface which holds

wafers or masks to be etched and an enclosing member which encloses the holding member to form a chamber for [the] a plasma, whereby plasma agitation occurs by an rf coil arrangement surrounding said enclosing member, whereby said rf coil arrangement produces a large voltage change near the enclosing member thereby enabling [the] cleaning of the enclosing member by the plasma, [itself] whereby furthermore plasma gasses can continuously be removed from said enclosing member by means of a suction pump arrangement attached to said enclosing member.

IN THE DRAWINGS

The drawings have been amended as kindly suggested by Examiner, a copy of the updated drawings is attached.